RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS

Meeting #5

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ACTION ITEM 3-16

Proposed Text to Accommodate the NIC/NAC/SIL Proposal

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SUMMARY

This paper is in support of Action Item 3-16: "Show how the proposed MASPS requirements outlined in WP-3-12 for NIC/NAC can be incorporated into DO-260A."

This proposal is derived from a more recent proposal for NAC, NIC, and SIL (Navigation Accuracy Category, Navigation Integrity Category, and Surveillance Integrity Level) as outlined by Tony Warren at the most recent SC-186 plenary in Seattle.

However, there is one very important way that this proposal departs from the NIC/NAC/SIL proposal that Tony presented to the SC-186 plenary. In this paper, I propose that the type code for the airborne position and surface position messages be tied to NIC rather than to NAC. Thus, whether airborne position messages carries barometric pressure altitude or geometric height above ellipsoid will be tied to the integrity containment radius (NIC code) rather than to the 95% accuracy radius (NAC code). I do this for several reasons:

(a) According to the present DO-242 MASPS, the NUC_P code is determined, for most NUC_P values, by HPL (Horizontal Protection Level), which is an integrity containment radius. It is only for the two tightest NUC_P values, $NUC_P = 8$ or 9, that NUC_P is determined by HFOM, the 95% accuracy radius.

(b) According to the present DO-260 MOPS, it is HPL, a containment radius, that is the primary determinant of the message type code, which also determines whether it is barometric or pressure altitude that is conveyed in the airborne position message.

(c) My company (UPS Aviation Technologies) and its parent company (the UPS airline) have already deployed 1090 MHz ADS-B transmitting equipment that determines the airborne position message type based on HPL rather than HFOM. There will be a serious backward compatibility issue with existing equipment if the message type code is tied to NAC (determined by HFOM) rather than to NIC (determined by HPL).

The following tables summarize the most recent NIC/NAC/SIL proposal, as I have modified it to associate the Altitude Type with NIC rather than with NAC.

NIC	Containment Radius, R_C	Altitude Type	Comment
0	Unknown, or > 20 NM	Baro Pressure Alt.	No Integrity
1	< 20 NM	Baro Pressure Alt.	RNP-10 containment radius
2	< 8 NM	Baro Pressure Alt.	RNP-4 containment radius
3	< 4 NM	Baro Pressure Alt.	RNP-2 containment radius
4	< 2 NM	Baro Pressure Alt.	RNP-1 containment radius
5	< 1 NM	Baro Pressure Alt.	RNP-0.5 containment radius
6	< 0.6 NM	Baro Pressure Alt.	RNP-0.3 containment radius
7	< 0.2 NM	Baro Pressure Alt.	RNP-0.1 containment radius
8	< 0.1 NM	Baro Pressure Alt.	e.g., RAIM GPS
9	< 75 m	Baro Pressure Alt..	Future System
10	< 25 m	Geometric Alt.	e.g., WAAS HPL
11	< 7.5 m	Geometric Alt.	e.g., LAAS HPL
12-15	[Reserved for progressively tighter integrity containment radii.]		

NAC_P	95% Accuracy Bound	Comment
0	HFOM ≥ 10 NM	No Integrity
1	HFOM < 10 NM	RNP-10 accuracy
2	HFOM < 4 NM	RNP-4 accuracy
3	HFOM < 2 NM	RNP-2 accuracy
4	HFOM < 1 NM	RNP-1 accuracy
5	HFOM < 0.5 NM	RNP-0.5 accuracy
6	HFOM < 0.3 NM	RNP-0.3 accuracy
7	HFOM < 0.1 NM	RNP-0.1 accuracy
8	HFOM < 0.05 NM	e.g., GPS, with SA on
9	HFOM < 30 m	e.g. GPS (no SA)
10	HFOM < 10 m, VFOM < 15 m	e.g., WAAS HPL
11	HFOM < 3 m, VFOM < 4 m	e.g., LAAS HPL
12-15	[Reserved for progressively tighter 95% accuracy bounds.]	

SIL	Probability of Unknowingly Exceeding the R_C Radius	Types of Applications That Need This Integrity Level
0	(No Integrity)	Non-Interfering Apps (No Hazard Level)
1	1×10^{-3}	Non-Essential Apps (Minor Hazard Level)
2	1×10^{-5}	Essential Apps (Major Hazard Level)
3	1×10^{-7}	Critical Apps (Severe Major Hazard Level)

2.2.3.2.3.1 "TYPE" Subfield in ADS-B Airborne Position Messages

The "TYPE" subfield is a 5-bit ("ME" bits 1 through 5, Message bits 33 through 37) field used to identify the ADS-B Message and differentiates the messages into several classes:

- Airborne Position messages,
- Surface Position messages,
- Airborne or Surface Position messages with no valid horizontal position information,
- Identification messages,
- Airborne Velocity messages,
- Aircraft Status messages,
- Aircraft Trajectory Intent messages,
- Aircraft Operational Coordination messages, and
- Aircraft Operational Status messages.

The message type subfield in Airborne Position messages also encodes the altitude precision classification, as well as identifying the altitude data as being either barometric or GNSS derived.

If the Version Number subfield in Aircraft Operational Status messages (see section 2.2.3.2.7.3.5) from a transmitting ADS-B participant is zero, then the message type subfield of the Airborne Position and Surface Position messages from that participant also encodes the measurement precision category (NUC_P), as indicated in Table 2.2.3.2.3.1-A. (If no Aircraft Operational Status messages are received from a transmitting ADS-B participant, then a receiving participant assumes that the transmitting participant's Version Number is zero.)

If the Version Number subfield in Aircraft Operational Status messages (section 2.2.3.2.7.3.5) from a transmitting ADS-B participant is 1 or greater, then the message type subfield (described here) and the NIC Supplement subfield (described in section 2.2.3.2.7.3.6) together encode the navigational integrity category (NIC), as indicated in Table 2.2.3.2.3.1-B.

Detailed definition of the "TYPE" subfield encodings that shall be used for all ADS-B messages are provided in Tables 2.2.3.2.3.1-A and -B. The ADS-B Airborne Position Messages use "TYPE" codes 9 through 18 and 20 through 22 as indicated in Tables 2.2.3.2.3.1-A and -B.

Table 2.2.3.2.3.1-A: "TYPE" Subfield Code Definitions (DF = 17 or 18) If Version Number = 0

Type Code	Format	Horizontal Protection Limit, HPL	95% Limits, m and n (HFOM and VFOM), On Horizontal and Vertical Position Error	NUC_P	Altitude Type
0	No Position Information			0	Baro Pressure Altitude or No Altitude Information
1	Identification (Category Set D)				*Not Applicable*
2	Identification (Category Set C)				*Not Applicable*
3	Identification (Category Set B)				*Not Applicable*
4	Identification (Category Set A)				*Not Applicable*
5	Surface Position	HPL < 7.5 m	μ < 3 m	9	No Altitude Information
6	Surface Position	7.5 m <= HPL < 25 m	3 m <= μ < 10 m	8	No Altitude Information
7	Surface Position	25 m <= HPL < 185.2 m (0.1 NM)	10 m <= μ < 92.6 m (0.05 NM)	7	No Altitude Information
8	Surface Position	HPL ≥ 185.2 m (0.1 NM)	μ ≥ 92.6 m (0.05 NM)	6	No Altitude Information
9	Airborne Position	HPL < 7.5 m	μ < 3 m	9	Baro Pressure Altitude
10	Airborne Position	7.5 m <= HPL < 25 m	3 m <= μ < 10 m	8	Baro Pressure Altitude
11	Airborne Position	25 m <= HPL < 185.2 m (0.1 NM)	10 m <= μ < 92.6 m (0.05 NM)	7	Baro Pressure Altitude
12	Airborne Position	185.2 m (0.1 NM) <= HPL < 370.4 m (0.2 NM)	92.6 m (0.05 NM) <= μ < 185.2 m (0.1 NM)	6	Baro Pressure Altitude
13	Airborne Position	370.4 m (0.2 NM) <= HPL < 926 m (0.5 NM)	185.2 m (0.1 NM) <= μ < 463 m (0.25 NM)	5	Baro Pressure Altitude
14	Airborne Position	926 m (0.5 NM) <= HPL < 1852 m (1.0 NM)	463 m (0.25 NM) <= μ < 926 m (0.5 NM)	4	Baro Pressure Altitude
15	Airborne Position	1852 m (1.0 NM) <= HPL < 3704 m (2.0 NM)	926 m (0.5 NM) <= μ < 1.852 km (1.0 NM)	3	Baro Pressure Altitude
16	Airborne Position	3.704 km (2.0 NM) <= HPL < 18.52 km (10 NM)	1.852 km (1.0 NM) <= μ < 9.26 km (5.0 NM)	2	Baro Pressure Altitude
17	Airborne Position	18.52 km (10 NM) <= HPL < 37.04 km (20 NM)	9.26 km (5.0 NM) <= μ < 18.52km (10.0 NM)	1	Baro Pressure Altitude
18	Airborne Position	HPL ≥ 37.04 km (20 NM)	μ ≥ 18.52 km (10.0 NM)	0	Baro Pressure Altitude
19	Airborne Velocity	*Not Applicable*	*Not Applicable*	*N/A*	[Note5]
20	Airborne Position	HPL < 7.5 m	μ < 3 m and ν < 4 m	9	GNSS Height (HAE)
21	Airborne Position	7.5 m <= HPL < 25 m	μ < 10 m and ν < 15 m	8	GNSS Height (HAE)
22	Airborne Position	HPL ≥ 25 m	μ ≥ 10 m or ν ≥ 15 m	TBD	GNSS Height (HAE)
23	Reserved for Test Purposes				
24	Reserved for Surface System Status				
25-27	Reserved				
28	Extended Squitter Aircraft Status				
29	Aircraft Trajectory Intent (i.e., Current/Next Trajectory Change Point)				
30	Aircraft Operational Coordination				
31	Aircraft Operational Status				

Table 2.2.3.2.3.1-B: "TYPE" Subfield Code Definitions (DF = 17 or 18) If Version Number = 1

Type Code	NIC Supplement (in Aircraft Op. Status Msg.)	Format	Integrity Containment Radius, R_C	NIC	Altitude Type
0	*Not Applicable*	No Position Information	*Not Applicable*	0	Baro Pressure Altitude or No Altitude Information
1	*Not Applicable*	Identification (Category Set D)	*Not Applicable*		*Not Applicable*
2	*Not Applicable*	Identification (Category Set C)	*Not Applicable*		*Not Applicable*
3	*Not Applicable*	Identification (Category Set B)	*Not Applicable*		*Not Applicable*
4	*Not Applicable*	Identification (Category Set A)	*Not Applicable*		*Not Applicable*
5	0	Surface Position	R_C < 7.5 m	11	No Altitude Information
6	0		7.5 m <= R_C < 25 m	10	No Altitude Information
7	1		25 m <= R_C < 75 m	9	No Altitude Information
	0		75 m <= R_C < 185.2 m (0.1 NM)	8	No Altitude Information
8	0		R_C ≥ 185.2 m (0.1 NM)	0	No Altitude Information
9	0	Airborne Position	R_C < 7.5 m	11	Baro Pressure Altitude
10	0		7.5 m <= R_C < 25 m	10	Baro Pressure Altitude
11	1		25 m <= R_C < 75 m	9	Baro Pressure Altitude
	0		75 m <= R_C < 185.2 m (0.1 NM)	8	Baro Pressure Altitude
12	0		185.2 m (0.1 NM) <= R_C < 370.4 m (0.2 NM)	7	Baro Pressure Altitude
13	0		370.4 m (0.2 NM) <= R_C < 1111.2 m (0.6 NM)	6	Baro Pressure Altitude
14	0		1111.2 m (0.6 NM) <= R_C < 1852 m (1 NM)	5	Baro Pressure Altitude
15	0		1852 m (1 NM) <= R_C < 3.704 km (2 NM)	4	Baro Pressure Altitude
16	0		3.704 km (2 NM) <= R_C < 7.408 km (4 NM)	3	Baro Pressure Altitude
	1		7.408 km (4 NM) <= R_C < 14.816 km (8 NM)	2	Baro Pressure Altitude
17	0		14.816 km (8 NM) <= R_C < 37.04 km (20 NM)	1	Baro Pressure Altitude
18	0		R_C ≥ 37.04 km (20 NM)	0	Baro Pressure Altitude
19	*Not Applicable*	Airborne Velocity	*Not Applicable*	*N/A*	[Note5]
20	0	Airborne Position	R_C < 7.5 m	11	GNSS Height (HAE)
21	0		R_C < 25 m	10	GNSS Height (HAE)
22	0		R_C ≥ 25 m	TBD	GNSS Height (HAE)
23	*Not Applicable*	Reserved for Test Purposes			
24	*Not Applicable*	Reserved for Surface System Status			
25-27	*Not Applicable*	Reserved			
28	*Not Applicable*	Extended Squitter Aircraft Status			
29	*Not Applicable*	Aircraft Trajectory Intent (i.e., Current/Next Trajectory Change Point)			
30	*Not Applicable*	Aircraft Operational Coordination			
31	*Not Applicable*	Aircraft Operational Status			

Notes for Tables 2.2.3.2.3.1-A and 2.2.3.2.3.1-A:

1. *"Baro Pressure Altitude" means barometric pressure altitude, relative to a standard pressure of 1013.25 millibars (29.92 in. Hg). It does* ***not*** *mean baro corrected altitude.*

2. *Type Codes 20 to 22 or Type Code 0 are to be used when valid "Baro Pressure Altitude" is not available.*

3. *After initialization, when horizontal position information is not available but altitude information is available, the airborne position message is transmitted with a type code of zero in bits 1-5, the barometric pressure altitude in bits 9 to 20, and bits 22 to 56 set to zero. If neither horizontal position nor barometric altitude information is available, then all 56 bitsof register 0,5 shall be set to zero. The zero type code field indicates that latitude and longitude information is not available, while the zero altitude field indicates that altitude information is not available. (See Appendix A)*

4. *HFOM may be derived from ARINC 429 Label 247. HPL and R_C may be derived from ARINC 429 Label 130.*

5. *The Airborne Velocity Message, message type code 19, contains a subfield that conveys the difference between "Barometric Pressure Altitude" and "GNSS Height (HAE)."*

2.2.3.2.3.1.1 Airborne Position Type Code if Version Number = 0 and HPL is Available

If

(a) the Version Number = 0 in the Extended Squitter Aircraft Operation Status message (section 2.2.3.2.7.3.5), and

(b) HPL (Horizontal Protection Limit) information is available from the navigation data source,

then the transmitting ADS-B subsystem shall use HPL and Altitude Type to determine the Message Type code used in the Airborne Position Message in accordance with Table 2.2.3.2.3.1-A.

Note 1: ADS-B transmitting equipment that conforms to the current version of this MOPS (i.e., DO-260A) should set Version Number = 1 in the Extended Squitter Aircraft Operational Status message. Therefore, the requirements of this subsection do not apply to such equipment. (See subsection 2.2.3.2.3.1.3 below.)

Note 2: ADS-B receiving equipment that conforms to the current version of this MOPS (i.e., DO-260A) will have to cope with ADS-B messages both from Version 0 equipment and from Version 1 equipment. Issues of backwards and forward compatibility between equipment conforming to Version 0 and Version 1 of this MOPS are addressed in subsection 2.2.3.2.7.3.6 below.

2.2.3.2.3.1.2 Airborne Position Type Code if Version Number = 0 and HPL is Not Available

If

(a) the Version Number = 0 in the Extended Squitter Aircraft Operational Status message (section 2.2.3.2.7.3.5), and

(b) HPL (Horizontal Protection Limit) information is NOT available from the navigation data source,

then the transmitting ADS-B subsystem shall use HFOM (95% bound on the horizontal position error), VFOM (95% bound on the vertical position error), and Altitude Type to determine the Type code used in the Airborne Position Message in accordance with Table 2.2.3.2.3.1-A.

Note 1: ADS-B transmitting equipment that conforms to the current version of this MOPS (i.e., DO-260A) should set Version Number = 1 in the Extended Squitter Aircraft Operational Status message. Therefore, the requirements of this subsection do not apply to such equipment.

Note 2: ADS-B receiving equipment that conforms to the current version of this MOPS (i.e., DO-260A) will have to cope with ADS-B messages both from Version 0 equipment and from Version 1 equipment. Issues of backwards and forward compatibility between equipment conforming to Version 0 and Version 1 of this MOPS are addressed in subsection 2.2.3.2.7.3.6 below.

2.2.3.2.3.1.3 Airborne Position Type Code if Version Number = 1

If the Version Number in the Extended Squitter Aircraft Operational Status Message (section 2.2.3.2.7.3.5) is 1, then the transmitting ADS-B subsystem shall use the integrity containment radius, R_C, and Altitude Type to determine:

(a) the Message Type code subfield in the Airborne Position message, and

(b) the NIC Supplement subfield in the Extended Squitter Aircraft Operational Status Message,

in accordance with Table 2.2.3.2.3.1-B.

Note 1: ADS-B transmitting equipment that conforms to the current version of this MOPS (i.e., DO-260A) should set Version Number = 1 in the Extended Squitter Aircraft Operational Status message. Therefore, the requirements of this subsection do apply to such equipment. (See subsection 2.2.3.2.3.1.3 below.)

Note 2: ADS-B receiving equipment that conforms to the current version of this MOPS (i.e., DO-260A) will have to cope with ADS-B messages both from Version 0 equipment and from Version 1 equipment. Issues of backwards and forward compatibility between equipment conforming to Version 0 and Version 1 of this MOPS are addressed in subsection 2.2.3.2.7.3.6 below.

2.2.3.2.4 "ADS-B Surface Position Messages

Format for the Surface Position Message "ME" field contents is defined in Figure 2.2.3.2.4. Each of the subfields is defined in the following subparagraphs.

2.2.3.2.4.1 "TYPE" Subfield in ADS-B Surface Position Messages

The "TYPE" subfield was previously defined for the Airborne Position Message in subparagraph 2.2.3.2.3.1 and remains the same for the ADS-B Surface Position Message, which uses Type Codes 5, 6, 7 and 8 only.

2.2.3.2.4.1.1 Surface Position Type Code if Version Number = 0 and HPL is Available

If

(a) the Version Number = 0 in the Extended Squitter Aircraft Operation Status message, and

(b) HPL (Horizontal Protection Limit) information is available from the navigation data source, then

the transmitting ADS-B subsystem shall use HPL to determine the Type Code used in the Surface Position Message in accordance with Table 2.2.3.2.3.1-A.

2.2.3.2.4.1.2 Surface Position Type Code if Version Number = 0 and HPL is Not Available

If

(a) the Version Number = 0 in the Extended Squitter Aircraft Operation Status message, and

(b) HPL (Horizontal Protection Limit) information is NOT available from the navigation data source, then

the transmitting ADS-B subsystem shall use HFOM (Horizontal Figure of Merit, a 95% accuracy bound on the horizontal position) to determine the Type code used in the Surface Position Message in accordance with Table 2.2.3.2.3.1-A.

2.2.3.2.4.1.3 Surface Position Type Code if Version Number = 1

If the Version Number in the Extended Squitter Aircraft Operational Status Message is 1, then the transmitting ADS-B subsystem shall use the integrity containment radius, R_C, to determine the value of:

(a) the Message Type subfield in the Surface Position Message, and

(b) the NIC Supplement subfield in the Extended Squitter Aircraft Operational Status Message,

in accordance with Table 2.2.3.2.3.1-B.

2.2.3.2.5 ADS-B aircraft Identification and Type Messages

2.2.3.2.6 ADS-B Airborne Velocity Information Messages

2.2.3.2.7 ADS-B Intent, Operational Coordination, and Operational Status Messages

Type codes 20, 30 and 31 have been identified for Aircraft Intent, Aircraft Operational Coordination, and Aircraft Operational Status. Structure of these messages is provided in the subsequent paragraphs.

2.2.3.2.7.1 "Aircraft Trajectory Intent" Messages

2.2.3.2.7.2 "Aircraft Operational Coordination" Messages

2.2.3.2.7.3 "Aircraft Operational Status" Messages

The Aircraft Operational Status Message is used to provide the current status of the aircraft. Format of the message is provided in Figure 2.2.3.2.7.3, while further definition of each of the subfields is provided in the subsequent paragraphs.

"AIRCRAFT OPERATIONAL STATUS" MESSAGE "ME" FIELD									
Msg Bit #	33 - 37	38 - 40	41 - 56	57 - 72	73 -75	76	77- 80	81 -82	83 - 88
"ME" Bit #	1 - 5	6 - 8	9 - 24	25 - 40	41 -43	44	45 - 48	49 -50	51 - 56
Field Name	Type = 31 [5]	Subtype [3]	Capability Class Codes [16]	Operational Mode [16]	Ver. No. [3]	NIC Supp. [1]	NAC [4]	SIL [2]	Not Assigned [6]
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB

Figure 2.2.3.2.7.3: "Aircraft Operational Status" ADS-B Event-Driven Message Format

2.2.3.2.7.3.1 "TYPE" Subfield in Aircraft Operational Status Messages

The "TYPE" subfield was previously defined for the Airborne Position Message in subparagraph 2.2.3.2.3.1 and remains the same for the Aircraft Operational Status Message, which uses Type Code 31.

2.2.3.2.7.3.2 "SUBTYPE" Field in Aircraft Operational Status Messages

The "SUBTYPE" field is a 3-bit ("ME" bits 6 though 8, Message bits 38 through 40) field used to indicate various type of Aircraft Operational Status messages as defined in Table 2.2.3.2.7.3.2.

Table 2.2.3.2.7.3.2:"SUBTYPE" Field in Aircraft Operational Status Message Encoding

Subtype Coding	Meaning
0	Message contains Aircraft Operational Status data as shown in Figure 2.2.3.2.7.3.
1-7	Reserved for future growth.

2.2.3.2.7.3.3 "Capability Class (CC)" Subfield in Aircraft Operational Status Message

2.2.3.2.7.3.4 "Operational Mode" Subfield in Aircraft Operational Status Messages

2.2.3.2.7.3.5 "Version Number" Subfield in Aircraft Operational Status Messages

The "Version Number" subfield is a 3-bit field ("ME" bits 73 to 75, Message bits 41 to 43) that indicates the version number of the MOPS to which the transmitting ADS-B subsystem complies.

Table 2.2.3.2.7.3.5:"Version Number" Subfield Encoding

Version Number	Meaning
0	The transmitting ADS-B subsystem complies with the initial version of this MOPS, RTCA DO-260.
1	The transmitting ADS-B subsystem complies with the "Revision A" version of this MOPS, RTCA DO-260A.
2-7	Reserved for future growth.

2.2.3.2.7.3.6 "NIC Supplement" Subfield in Aircraft Operational Status Messages

The "NIC Supplement" subfield is a 1-bit field "ME" bit 76, Message bit 44). This field is used, if the Version Number subfield is 1 or above, together with the Message Type subfield in the Airborne Position (section 2.2.3.2.3.1) and the Surface Position (section 2.2.3.2.4.1) messages, to encode the Navigation Integrity Category (NIC).

Note: The NIC Supplement subfield permits the Navigation Integrity Category (NIC) in messages from Version 1 and above transmitting subsystems to be encoded in a way that is backwards compatible with the encoding of the Navigation Uncertainty Category for Position (NUC_P) in messages from Version 0 transmitting subsystems.

Table 2.2.3.2.7.3.6-A shows how a Version 1 or above ADS-B receiving subsystem shall interpret the NUC_P codes that it receives from a Version 0 ADS-B transmitting subsystem.

Table 2.2.3.2.7.3.6-A: Interpretation of NUC_P Codes from Version 0 Transmitting Subsystems When Received by Version 1 or Above ADS-B Receiving Subsystems.

Values Sent By Version 0 Transmitting Subsystem		Values Inferred by Version 1 or Above Receiving Subsystem			Notes
Message Type Code	**NUC_P**	**NAC** (subsection 2.2.3.2.7.3.7)	**NIC** (Table 2.2.3.2.3.1-B)	**SIL** (section 2.2.3.2.7.3.8)	
0	0	0 (HFOM ≥ 10 NM)	0 (R_C ≥ 20 NM)	0 (No Integrity)	
5	9	11 (HFOM < 3 m)	11 (R_C < 7.5 m)	2 ("5 nines")	
6	8	10 (HFOM < 10 m)	10 (R_C < 25 m)	2 ("5 nines")	
7	7	8 (HFOM < 0.05 NM)	8 (R_C < 0.1 NM)	2 ("5 nines")	
8	6	0 (HFOM ≥ 0.05 NM)	0 (R_C ≥ 0.1 NM)	0	[1]
9	9	11 (HFOM < 3 m)	11 (R_C < 7.5 m)	2 ("5 nines")	
10	8	10 (HFOM < 10 m)	10 (R_C < 25 m)	2 ("5 nines")	
11	7	8 (HFOM < 0.05 NM)	8 (R_C < 0.1 NM)	2 ("5 nines")	
12	6	7 (HFOM < 0.1 NM)	7 (R_C < 0.2 NM)	2 ("5 nines")	
13	5	6 (HFOM < 0.3 NM)	6 (R_C < 0.6 NM)	2 ("5 nines")	
14	4	5 (HFOM < 0.5 NM)	5 (R_C < 1.0 NM)	2 ("5 nines")	
15	3	4 (HFOM < 1.0 NM)	4 (R_C < 2.0 NM)	2 ("5 nines")	
16	2	1 (HFOM < 5.0 NM < 10 NM)	1 (R_C < 10 NM < 20 NM)	2 ("5 nines")	
17	1	1 (HFOM < 10 NM)	1 (R_C < 20 NM)	2 ("5 nines")	
18	0	0 (HFOM ≥ 10 NM)	0 (R_C ≥ 20 NM)	0 ("No Integrity")	
20	9	11 (HFOM < 3 m, VFOM < 4 m)	11 (R_C < 7.5 m)	2 ("5 nines")	[3]
21	8	10 (HFOM < 10 m, VFOM < 15 m)	10 (R_C < 25 m)	2 ("5 nines")	[3]
22	TBD	0 (HFOM ≥ 10 m or unknown)	0 (R_C ≥ 25 m or unknown)	0 (No Integrity)	[3]

Note: Table 2.2.3.2.7.3.6-B shows how a Version 0 ADS-B receiving subsystem would interpret the NIC codes that it receives from a Version 1 or above ADS-B transmitting subsystem.

Table 2.2.3.2.7.3.6-B: Interpretation of NIC Codes (from Version 1 or Above Transmitting Subsystems) When Received by Version 0 Receiving Subsystems.

Type Code in Message From Version 1 Transmitting Subsystem	*NIC Value from Version 1 or Above Transmitting Subsystem*	*NUC_P Value Assumed by Version 0 Receiving Subsystem*	*Notes*
0	*0 (R_C unknown or ³ 20 NM)*	*0 (HPL ³ 20 NM , or HFOM ³ 10 NM)*	
5	*11 (R_C < 7.5 m)*	*9 (HPL < 7.5 m, or HFOM < 3 m)*	
6	*10 (R_C < 25 m)*	*8 (HPL < 25 m, or HFOM < 10 m)*	
7	*8 or 9 (R_C < 0.1 NM)*	*7 (HPL < 0.1 m, or HFOM < 0.05 NM)*	
8	*0 (R_C ³ 0.1 NM)*	*6 (HPL ³ 0.1 m, or HFOM ³0.05 NM)*	*[1]*
9	*11 (R_C < 7.5 m)*	*9 (HPL < 7.5 m, or HFOM < 3 m)*	
10	*10 (R_C < 25 m)*	*8 (HPL < 25 m, or HFOM < 10 m)*	
11	*8 or 9 (R_C < 0.1 NM)*	*7 (HPL < 0.1 m, or HFOM < 0.05 NM)*	
12	*7 (R_C < 0.2 NM)*	*6 (HPL < 0.05 NM, or HFOM < 0.1 NM)*	
13	*6 (R_C < 0.6 NM)*	*5 (HFOM < 0.25 NM, or HPL < 0.5 NM)*	*[2]*
14	*5 (R_C < 1.0 NM)*	*4 (HPL < 1.0 NM, or HFOM < 0.5 NM)*	
15	*4 (R_C < 2 NM)*	*3 (HPL < 2 NM, or HFOM < 1.0 NM)*	
16	*2 or 3 (R_C < 8 NM)*	*2 (HPL< 10 NM, or HFOM < 5.0 NM)*	
17	*1 (R_C < 20 NM)*	*1 (HPL < 20 NM, or HFOM < 10 NM)*	
18	*0 (R_C ³ 10 NM)*	*0 (HPL ³ 20 NM, or HFOM ³ 10 NM)*	
20	*11 (R_C < 7.5 m)*	*0 (HPL and HFOM unknown)*	*[3]*
21	*10 (R_C < 25 m)*	*0 (HPL and HFOM unknown)*	*[3]*
22	***TBD*** *(R_C ³ 25 m)*	*0 (HPL and HFOM unknown)*	*[3]*

Notes for Tables 2.2.3.2.7.3.6-A and -B:

[1]. In Table 2-11 in the initial (DO-260) version of this MOPS, a NUC_P value of 6 was assigned to surface position messages with type code = 8. This coding is preserved in Table 2.2.3.2.7.3.6-B because that table shows how equipment that conforms to the initial DO-260 MOPS will interprets this message type. However, Table 2.2.3.2.7.3.6-A specifies that surface position messages with type code = 8 should be interpreted by Version 1 (i.e., DO-260A) receiving equipment as specifying that NIC, NAC, and NIL should all be 0. This is because the information in the message is insufficient to indicate the value of either the R_C integrity containment radius or the HFOM 95% horizontal accuracy bound.

[2] In the initial (DO-260) version of this MOPS, message type codes 20 to 22 were determined primarily by the HPL containment radius and secondarily, if the HPL value was unknown, by the 95% horizontal and vertical accuracy bounds. However, the initial version (DO-242) of the ADS-B MASPS required that NUC_P codes of 8 and 9 should be determined by only by the 95% horizontal and vertical accuracy bounds. Therefore, a Version 1 1090 MHz ADS-B receiving subsystem cannot reliably assign a NIC code based on airborne position messages of message types 20 to 22 from Version 0 ADS-B transmitting subsystems. It is for that reason that Table 2.2.3.2.7.3.6-A specifies that message types 20 to 22 from Version 0 transmitting subsystems should be interpreted by Version 1 and above receiving subsystems as conveying a NIC code of 0, meaning "no integrity" or "unknown integrity."

[3] A Version 1 transmitting subsystem will set the Type Code in the Airborne Position Message to 13 whenever the HFOM is less than 0.3 NM, but a Version 0 receiving subsystem will assume that Type Code = 13 means that HFOM is less than 0.25 NM, rather than 0.3 NM. ***It is assumed that there are no client applications that would demand HFOM = 0.25 NM rather than HFOM = 0.3 NM.***

2.2.3.2.7.3.7 Navigation Accuracy Category (NAC) Subfield in Aircraft Operational Status Messages

The Navigation Accuracy Category (NAC) subfield is a 4-bit field ("ME" bits 77 through 80, message bits 45 through 48) that indicates 95% accuracy bounds (HFOM and VFOM) on the horizontal and vertical positions. The measure of horizontal accuracy, HFOM, is the radius of a circle, with center at the position indicated in the Airborne Position or Surface Position message, that is assured to contain, with 95% probability, the true position of the A/V aboard which the transmitting ADS-B subsystem resides – provided that everything is working properly. Likewise, the measure of vertical accuracy, VFOM, is a 95% accuracy bound on the vertical position. Encoding of the NAC subfield shall be as specified in Table 2.2.3.2.7.3.7.

Table 2.2.3.2.7.3.7: Navigation Accuracy Category Encoding.

NAC	95% Accuracy Bounds on Horizontal and Vertical Position (HFOM and VFOM)	Comment
0	Unknown Accuracy	
1	HFOM < 10 NM	RNP-10 accuracy
2	HFOM < 4 NM	RNP-4 accuracy
3	HFOM < 2 NM	RNP-accuracy
4	HFOM < 1 NM	RNP-1 accuracy
5	HFOM < 0.5 NM	RNP-0.5 accuracy
6	HFOM < 0.3 NM	RNP-0.3 accuracy
7	HFOM < 0.1 NM	RNP-0.1 accuracy
8	HFOM < 0.05 NM	e.g., GPS with SA on
9	HFOM < 30 m	e.g., GPS (no SA)
10	HFOM < 10 m, VFOM < 15 m	e.g., WAAS accuracy
11	HFOM < 3 m, VFOM < 4 m	e.g., LAAS accuracy
12 - 15	Reserved for progressively tighter 95% accuracy bounds.	

2.2.3.2.7.3.8 Surveillance Integrity Level (SIL) Subfield in Aircraft Operational Status Messages

The Surveillance Integrity Level (SIL) subfield is a 2-bit field ("ME" bits 81 and 82, message bits 49 and 50) that indicates the degree of integrity of the position indicated by the Airborne Position or Surface Position message. This integrity level is expressed in terms of the probability that the true position of the transmitting aircraft might lie outside the NIC containment radius, R_C, without the possibility of its lying outside that radius being detected at the transmitting aircraft. The encoding of the SIL subfield shall be as specified in Table 2.2.3.2.7.3.8.

Table 2.2.3.2.7.3.8: Surveillence Integrity Level (SIL) Encoding.

SIL	Probability That the A/V's True Position Might Lay Outside the Containment Radius, Without Being Detected	Comment
0	No Integrity	(Non-Interfering / No Hazard)
1	<= 1×10^{-3} per hour	(Non-Essential / Minor Hazard)
2	<= 1×10^{-5} per hour	(Essential / Major Hazard)
3	<= 1×10^{-7} per hour	(Critical / Severe Major Hazard)

2.2.3.2.7.3.9 "NOT ASSIGNED" Subfield in Aircraft Operational Status Messages

The "NOT ASSIGNED" subfield is a 6-bit ("ME" bits 51 through 56, message bits 83 through 88) field reserved for future application.